Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Load (TMDL)

For

West Fork Sni-a-Bar Creek
Jackson County, Missouri

Completed: November 21, 2005
Approved: January 6, 2006

Draft Phased Total Maximum Daily Loads (TMDL)
For West Fork Sni-a-BarCreek


State map showing location of watershed

Name: West Fork Sni-a-Bar Creek

Location: Near Lake Lotawana, Jackson County, MO

Hydrologic Unit Code (HUC): 10300101-1101

Water Body Identification (WBID): 0400

Missouri Stream Class: The impaired segment of West Sni-a-Bar Creek is a Class P stream[1]

Beneficial Uses:
- Livestock and Wildlife Watering,
- Protection of Warm Water Aquatic Life
- Human Health Associated with Fish Consumption

Size of Impaired Segment: 2 miles is identified in the 2002 303(d) list

Location of Impaired Segment: SE ¼, Section 21, Township 48N, Range 30W to NW ¼, NW ¼, Section 33, Township 48N, Range 30W

Pollutants: Biochemical Oxygen Demand (BOD), Volatile Suspended Solids (VSS)

Pollutant Source: City of Lake Lotawana's Wastewater Treatment Lagoon

Permit Number: National Pollutant Elimination Discharge System (NPDES), State Operating Permit, MO-0055425

TMDL Priority Ranking: High

1. Background and Water Quality Problems

West Fork Sni-a-Bar Creek is on the 2002 303(d) list due to high BOD, which causes low Dissolved Oxygen (DO) and high VSS resulting from discharges from the Lake Lotawana Wastewater Treatment Plant (WWTP). The TMDL priority ranking for West Fork Sni-a-Bar Creek is high. This TMDL was calculated at critical low flow conditions.

[1] Class P streams have permanent flow, which support aquatic life. See 10 CSR 20-7.031(1)(F)

The beneficial uses of West Fork Sni-a-Bar Creek are impaired for warm water aquatic life because of the effects of BOD and VSS on DO and ultimately aquatic life. DO is essential for most aquatic life and settled solids smother the streambed habitat for aquatic organisms, like invertebrates and fish eggs.

Defining the Problem:
The City of Lake Lotawana's WWTP consists of a three-cell lagoon with sludge retained in the lagoon. The facility's design flow is 0.287 MGD and the design population is 2,300 people. The facility discharges wastewater to West Fork Sni-a-Bar Creek. West Fork Sni-a-Bar Creek continues north and then east through Jackson County and then northeasterly through Lafayette County to the Missouri River. The city's WWTP has been in non-compliance in the past for exceeding existing permit limits. The Missouri Department of Natural Resources (the department) has cited the city for those violations.

The department conducted two stream surveys of West Fork Sni-a-Bar Creek near Lake Lotawana on August 8-9, 2001 and July 15-16, 2003. The purpose of the surveys was to quantify pollutant loading from Lake Lotawana's lagoon system during minimal summer flows. The sampling survey indicated the WWTP discharges of BOD and Ammonia were causing the impairment to West Fork Sni-a-Bar Creek (datasheet, Attachment B) even when the facility is meeting permit limits. The City of Lake Lotawana hired Midwest Environmental Consultants (MEC) Water Resources to develop a Waste Load Allocation (WLA) based on the department's sampling data. The city was anxious to upgrade the WWTP to be in compliance with state regulations and protect the steam. The city expressed concern that a requirement for Nitrogen (N) limits would be difficult and expensive to meet. They did agreed to construct a 0.3-MGD advanced treatment wastewater facility with strict Ammonia as Nitrogen (($NH_{3)}$-N) limits, which should be adequate to protect the stream.

The city has a maximum storage of 9,000-acre feet of water. The spillway for the lake contributes to the flow of the creek upstream of the WWTP during part of the year. The spillway is designed as a surface water discharge. During high flow conditions, the spillway releases significant flow over the high spillway resulting in a remarkable waterfall and providing aeration to the stream (see Attachment C, the lake overflow in June, 2005). During low flow conditions there may be little, to no, flow over the dam and hence, there is little lake influence on the stream during summer low flow conditions. The model was run based on zero flow from the lake.

The 2001 and 2003 West Fork Sni-a-Bar Creek water quality investigation concluded that the discharge from Lake Lotawana's lagoon is responsible for depressed levels of DO in West Fork Sni-a-Bar Creek below the treatment plant discharge. Because there are no numeric criteria for VSS, general water quality criteria for unsightly bottom deposits, color, or turbidity, apply. Sampling identified VSS but it is not modeled. However, conversion from a lagoon treatment plant to a mechanic WWTP should significantly reduce the algae generated. The new operating permit for the mechanical plant requires a 75% reduction in the monthly Total Suspended Solids (TSS) limit to protect the stream.

The data in Attachment B show instances when DO levels in the creek have fallen below the state standard of 5.0 mg/L. The low DO levels were measured on August 8-9, 2001 and July 15-16, 2003. The 2001 morning samples taken upstream of the treatment plant were slightly lower than afternoon readings, indicating that there is not a significant amount of algae (VSS) in the stream to produce afternoon oxygen. The 2001 samples taken at the treatment plant discharge have large swings from early morning to afternoon, suggesting that there is significant algae in the stream that is respiring in the night (using oxygen) and photosynthesizing in the day (producing oxygen). This evidence agrees with the department's inspection report from September 2001 that indicated there were large amounts of algae in the stream. The inspection report also indicates that the lagoon was not meeting the permit limits of 45 mg/L BOD and 80 mg/L TSS. The 2003 sampling data does not identify large diurnal swings in DO values.

Land Use:
MEC Water Resources' study identifies land use within the 23 square-mile watershed upstream of the Buckner-Tarsney Bridge as 41.2% grassland, 30.9% row crop agriculture, 20% forest, 5.7% open water, 2% barren and 0.3% urban. The attached Natural Resource Conservation Service land use map has very similar land use percentages (Attachment D). The area along the stream, below the dam, is a forested riparian corridor. Upstream of the WWTP discharge there are three wetland ponds between the stream and the wastewater treatment lagoons. There is a significant forested riparian corridor below the lagoon discharge to the stream. The new WWTP will discharge approximately 0.5 miles downstream of the existing discharge. There are fields on both sides of the stream downstream from the future discharge point but there is wooded riparian corridor along portions of the stream. The stream is characteristic of a prairie stream with low gradient, soil banks and streambed, and turbid water except below the spillway, (see attached pictures of the stream). There was no evidence of point or nonpoint sources of BOD upstream of the WWTP. Low DO upstream of the treatment plant may be related to natural background levels of oxygen during low flow conditions. The WLA study indicates the soils making up the streambed, have a high organic content that increases the BOD. The spillway does create a shale gravel bar (from the thick shale layer jutting out into the cascading waterfall) downstream of the plunge pool scoured out by the waterfall. Shale is a sedimentary rock that does not transmit water well but will breakdown to mud.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

Designated Uses:
The designated uses of West Fork Sni-a-Bar Creek, WBID 0400, are Livestock and Wildlife Watering, Warm Water Aquatic Life and Human Health-Fish Consumption. Warm Water Aquatic Life is the impaired use in West Fork Sni-a-Bar Creek. The stream is classified as a Class "P" stream, having permanent flow. The stream classifications and designated uses may be found at 10 CSR 20-7.031(1) C and Table H. Lake Lotawana is the only permitted facility that discharges to the 303 (d) listed segment of West Sni-a-Bar Creek.

Anti-degradation Policy:
Missouri's Water Quality Standards (WQS) include the U.S. Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier I-Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

Tier II-Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier III- Protects the quality of outstanding national resources, such as waters of national and state parks and wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria:
VSS
Stream surveys conducted during summer low flows by the department resulted in West Fork Sni-a-Bar Creek being placed on the 1998 303(d) list of impaired waters for the presence of VSS. There is no numeric standard for VSS. Deposits of excessive algae (VSS) or sludge in waters of the state are interpreted as violations of the general (narrative) criteria of the WQS. These standards may be found in 10 CSR 20-7.031(3)(A) and (C) where it states:

- "Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses."
- "Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses."

BOD_5

DO is the WQS that is exceeded in West Fork Sni-a-Bar Creek. DO is not a pollutant and cannot be allocated in a TMDL. The determination of instream DO is a function of the physical, chemical, and biological processes. Demands for oxygen arise from the bacterial decomposition of organic matter either introduced to or generated within the stream and from chemical loads introduced to the stream. Oxygen can be restored to the system through photosynthesis by plants and reaeration of the stream. Photosynthesis and reaeration rates depend on sunlight and temperature and these parameters must also be considered when evaluating the aquatic community and DO. Also gradient of the stream, bottom roughness, channel shape and sediment oxygen demand from the organic matter found in certain soils that can make up a steambed, all effect the stream's DO levels. Evaluation of instream DO is therefore a complex problem when all the processes are in play.

Because the wastewater contribution is a major source, a first step in rectifying the instream impairment is to establish limits on the discharge. BOD_5 is the parameter used to determine the impact wastewater will have on DO levels in a receiving stream. There is no numeric criterion in the WQS for BOD_5. Since DO cannot be allocated to the discharger, DO is linked to BOD_5. BOD_5 is a pollutant that is measurable and may be allocated in a TMDL. BOD_5 is composed of Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD). NBOD can be estimated directly from NH_3-N. The numeric link between DO and BOD is generated by the water quality model QUAL2E, and is supported by EPA. The QUAL2E model calculates BOD_5 by using CBOD and Ammonia data from actual sample analyses.

The city is ready to construct a mechanical treatment plant. Calibration for the QUAL2E model for the existing conditions, however, is based on the current lagoon system. Waste characteristics of a mechanical plant are dramatically different than a lagoon system. The use of the instream data collected by the department can therefore help guide the decision about a wasteload for the upgraded facility. A verified model will have to wait until the new plant is constructed to ensure that the State WQS for DO[2] is achieved.[3] Limiting discharges from the facility in and of itself may not be sufficient to ensure that the DO standard is met because of the effects of other instream characteristics controlling reaeration. Other targets must therefore be considered.

This TMDL provides for assessment endpoints of instream DO and NH_3-N and will be implemented in multiple phases. If additional assessments are necessary to demonstrate fully supporting aquatic life uses of the stream, Phase Two will be conducted.
Phase One will include WLAs for Ammonia and BOD_5 for Lake Lotawana's treatment plant, as described under *Implementation*, page 9. That WLA represents limits achievable by a modern advanced treatment mechanical plant using activated sludge and extended aeration processes, including denitrification, grit removal, secondary sedimentation, macrofiltration and ultraviolet disinfection. This plant is expected to achieve a 75% or greater reduction from the current level of 45 mg/L of BOD_5 to

[2] 10 CSR 20-7.031(4)(J)
[3] 10 CSR 20-7.031(4)(A)(3)

10 mg/L BOD_5 and from 80 mg/L TSS to 15 mg/L TSS. Ammonia limits of 1.4 mg/L summer and 2.2 mg/L winter are included in the permit. The permit also includes instream monitoring. The draft operating permit that will take effect once the construction of the new WWTP is complete has a required compliance schedule and an evaluation report to ensure that the plant will perform as designed.

The stream response as measured by DO will guide the need for Phase Two assessment. However, if after the upgrade, the stream remains impaired, additional measures would be evaluated and implemented to restore the stream's designated use for warm water aquatic life. Impairment unrelated to the WWTP will require stream restoration best management practices, which will achieve the state WQS.

Table 1. Summary of Numeric In-stream Targets

Dissolved Oxygen (mg/L) Criteria	5.0 mg/L
Ammonia (mg/L, May-October (pH 7.8, Temperature 26º C, Limited Warm Water Fishery)	1.4 mg/L
Ammonia (mg/L) November- April (pH 6.7, Temperature 6º C, Limited Warm Water Fishery)	2.2 mg/L

A summer temperature of 26º C with a pH of 7.8 Su and a winter temperature of 6ºC with a pH of 6.7 Su were chosen to reflect typical conditions for this watershed.

3. Calculation of Load Capacity

Load capacity is defined as the maximum pollutant load that a waterbody can assimilate without violating WQS. For the DO capacity, the target was set based on a BOD_5 limit for a new advanced treatment facility, which is included in the draft operating permit. The Ammonia limits are based on achieving instream WQS. The ability of these limits to adequately protect the stream's designated uses can only be defined after the new facility has been constructed (construction began in Fall of 2005) and the model recalibrated to more accurately reflect the attained instream water quality. For Phase One of this TMDL the Load Capacity was calculated by this formula: *Permit limit average daily load =(Design flow of facility in cfs) times (effluent pollutant concentration in mg/L) times (the constant 5.395 to convert to pounds/day.)*

Average Monthly BOD_5 Phase One
0.464 cfs*10 mg/L*5.395= 25.03 lb/day

Average Monthly Ammonia Phase One
Summer:
0.464cfs*1.4 mg/L*5.395=3.50 lb/day

Winter:
0.464 cfs* 2.2 mg/L*5.395=5.51 lb/day

4. Load Allocation (Non-Point Source Load)

Non-point source loads are those other than point source loads. Non-point source impacts are not considered to be causing the low DO above the lagoon discharge during critical low flows. The potential of low natural background DO exists and may be addressed in Phase Two of this TMDL. The forested riparian corridor upstream of the lagoon outfall is the best possible environment to protect stream quality. Forested riparian corridors provide a filter for water draining to the stream. It reduces the impact of rain and reduces stream bank erosion by stabilizing banks with trees and vegetation. The vegetative corridor also takes up excess nutrients that would otherwise be washed into the stream. Therefore the load allocation for non-point source is zero.

Phase Two of this TMDL will address stream response as measured by DO. If Phase Two monitoring and assessment indicate continued impairment after the construction of the advanced treatment plant, then Phase Two will be employed.

5. WLA (Point Source Loads)

The Lake Lotawana lagoon is the only point source load discharging to or impacting the impaired segment of West Fork Sni-a-Bar Creek and the treatment lagoon provided 26% of the flow to the stream during the 2003 survey. The city is eliminating all of the small wastewater discharges to the city during the plant construction period by routing those flows to the new WWTP. Loads to the stream are based on the city's treatment plant effluent and are listed in Table 2. The WLA for VSS is a required percent reduction from 80 mg/L to 15 mg/L VSS limit in the facility's NPDES permit; an approximately 80% reduction.

Summary of Loads

Table 2. Loads to West Fork Sni-a-Bar Creek near Lake Lotawana, MO (pounds/day - based on 30 day averages)

		Point Load lbs/day	Non-point Load	Margin of Safety lbs/day	Load Capacity lbs/day
BOD_5		22.53	0	2.5	25.03
Ammonia	Summer	3.15	0	0.35	3.50
	Winter	4.96	0	0.55	5.51

6. Margin of Safety

The [explicit 10%] margin of safety (MOS) is required in the TMDL calculation to account for the uncertainties in scientific and technical understanding of water quality in natural systems. This 10% explicit MOS will provide additional protection to the stream

since the permit limits are based on a monthly and weekly average instead of a daily maximum.

7. Seasonal Variation

Seasonal variation was simulated in the QUAL2E model via the use of lower water temperatures, lower Ammonia and CBOD decay coefficients and adjustments to seasonal low flow values. Seasonal limits for Ammonia are necessary because decay of these substances is biologically mediated and varies with water temperature and because DO gas saturation varies with water temperature.

8. Monitoring Plan For TMDLs Developed Under the Phased Approach

Permit requirements include sampling the effluent for $BOD_{5,}$ TSS, Temperature, Oil and Grease, Fecal Coliform and NH3-N. Phase One includes permit requirements for instream monitoring both upstream and at the ¼-mile mixing zone downstream of the outfall. The permittee will collect Ammonia, DO, Temperature and pH samples and other information necessary to assess plant performance and the stream recovery. The department will conduct a post construction water quality survey approximately one year after construction completion to determine if the stream is improving.

9. **Implementation Plans**

The draft operating permit for the proposed construction will assure that additional measures can be required should the plant fail to operate as necessary to meet WQS. A reopener clause, the WET test, and a schedule of compliance are included in the permit. The permit requires that the permittee, under the supervision of a professional engineer, collect and test samples of wastewater effluent, measure flow, and record all maintenance and operational problems experienced with the WWTP during the first 34 months of operation. The city will submit a preliminary engineering report prepared by a professional engineer that evaluates the WWTP operations. Instream monitoring will be done on a regular basis to assure compliance with Missouri WQS. These TMDLs will be incorporated into Missouri's Water Quality Management Plan. At the end of five years from the date of the issuance of the new state operating permit, the city's engineer will assess the operation and maintenance of the WWTP. Should the plant fail to meet the design expectations, the consultant will recommend options for replacement or modification of the plant.

Local involvement is vital to the success of any TMDL implementation plan. The city hired consultants to complete the WLA, design the new plant, and has entered into construction contracts. The city is financing this construction with a lease purchase from the Missouri Public Utilities Alliance.

10. Reasonable Assurances

The state operating permit requirements stated above assure that the permit can be reopened following the assessment and subsequently require implementation of additional measures to meet WQS. Monitoring and assessment of water quality in response to the implementation measures will guide decisions on additional actions necessary to ensure attainment of WQS. The city agreed to this adaptive management process which gives an assurance that they will be responsible for the WWTP operations and effluent.

The department has the delegated authority to write and enforce NPDES permits. Inclusion of effluent limits in the State Operating Permit, determined from the allocations in the WLA and the Water Quality Review Sheet, and established in this TMDL, should provide reasonable assurance that instream WQS will be met. However, should additional treatment or other water quality management practices, unrelated to the wastewater system be deemed necessary, the permittee will only be accountable for improvements to city-owned facilities.

11. **Public Participation**

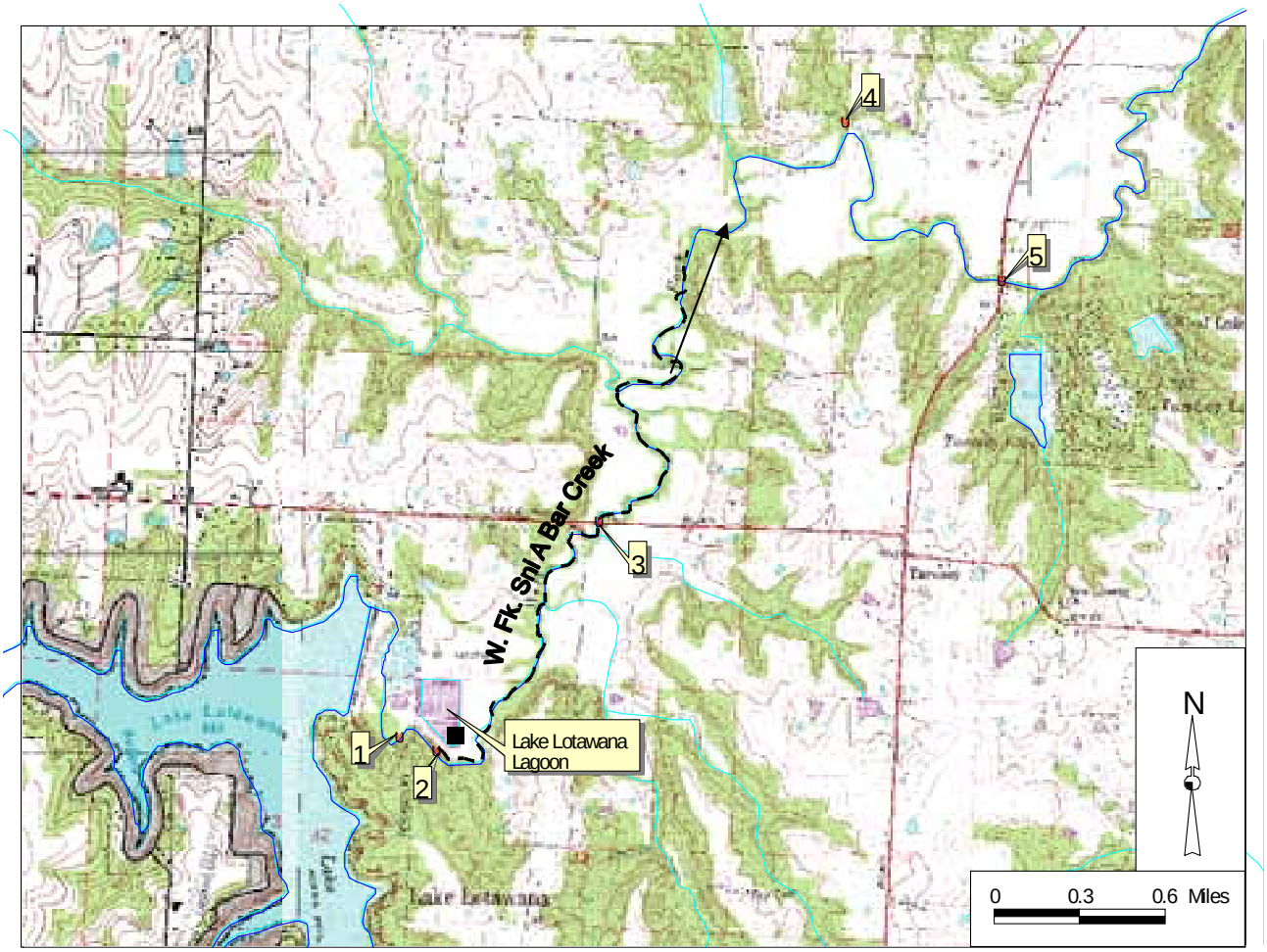
The construction permit for the Lake Lotawana WWTP construction was placed on public notice June 24, 2005. This TMDL was placed on public notice August 26, 2005 to September 25, 2005. Comments were received from MEC Water Resources. Groups receiving the public notice included the Clean Water Commission, the city, stream team members in the watershed, area legislators, and others who routinely receive public notice of NPDES permits. Copies of the public notice, comments and the department's response to comments are on file with the department.

12. Administrative Record and Supporting Documentation:

An administrative record on the West Fork Sni-a-Bar Creek TMDL has been assembled and is being kept on file with the department, including the following:

Topographical map of impaired segment with Sampling Station Numbers, attachment A
Sampling Data, attachment B
Photos of the stream and lake spillway, attachments C, D, E, F
Land use map, Attachment G
Input and output documents
WLA study by MEC Water Resources, Inc.
State Operating Permit MO-0055425
Public notice document
West Fork Sni-a-Bar Creek information sheet
Copy of the comment letter and the department's response letter

Impaired Segment of West Fork Sni-A-Bar Creek in Jackson County, Missouri, with Sampling Sites



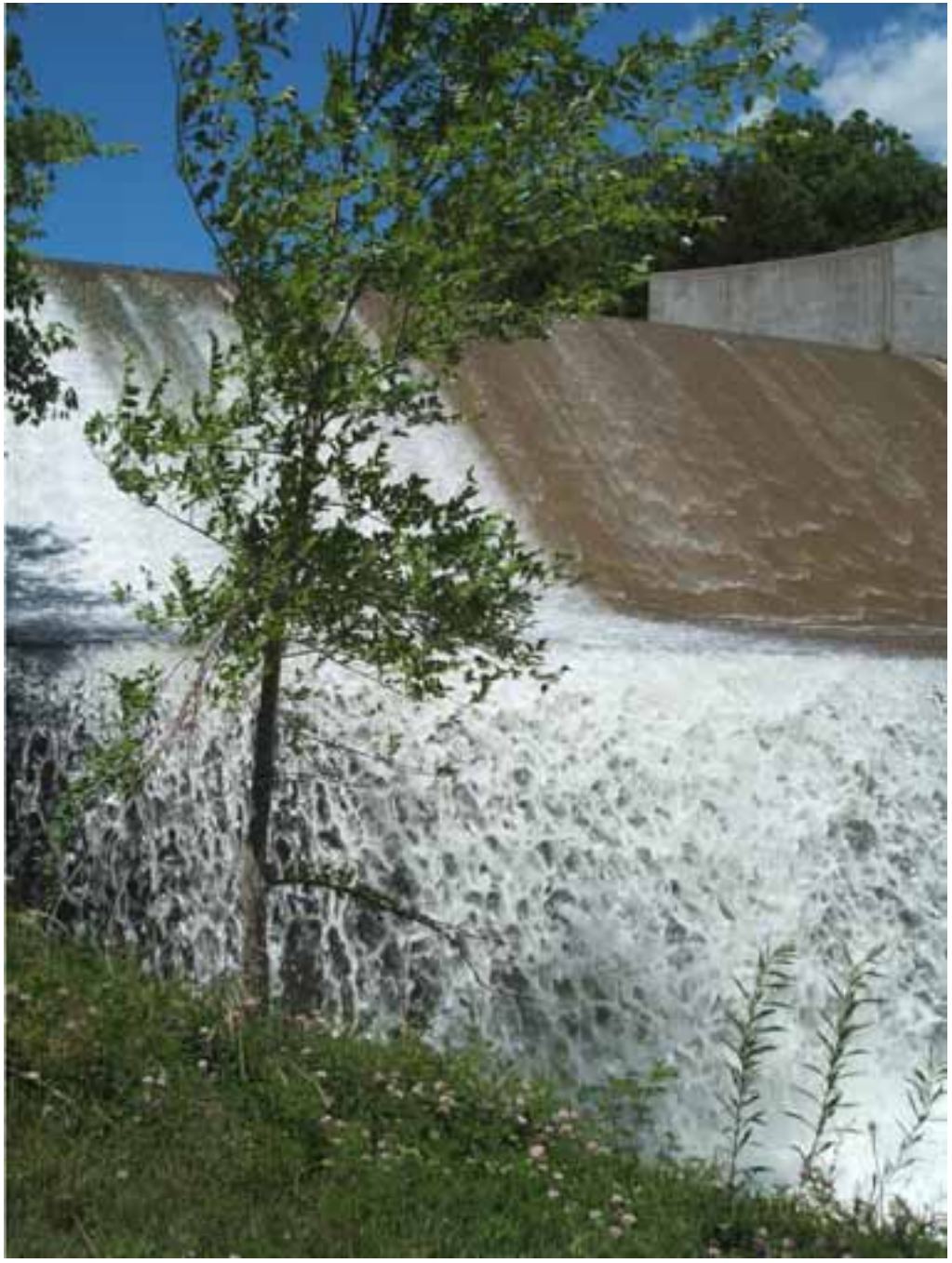
Impaired segment **Direction of flow**

Sampling Site Index
1 – W. Fk. Sni-A-Bar 0.1 mile upstream of Lake Lotawana Lagoon
2 – Lake Lotawana Lagoon Outfall
3 – W. Fk. Sni-A-Bar 1.1 miles downstream of Lake Lotawana Lagoon
4 – W. Fk. Sni-A-Bar 3.2 miles downstream of Lake Lotawana Lagoon
5 – W. Fk. Sni-A-Bar 4.4 miles downstream of Lake Lotawana Lagoon

Attachment A

Site # (See map)	Date	Time	Site	Flow	C	F	DO	KJN	NH3N	NO3N	O-N	TN	TP	TSS	VSS	CBOD
1	8/8/2001	640	400/7.8		26	78.8	4.2	0.53	0.02499	0.14	0.50501	0.67	0.07	24		0.99
1	8/8/2001	1320	400/7.8	0.43	28	82.4	5	0.56	0.02499	0.11	0.53501	0.67	0.09	71		0.99
1	8/9/2001	630	400/7.8		27	80.6	4	0.43	0.05	0.13	0.38	0.56	0.08	25		0.99
1	8/9/2001	1300	400/7.8		29	84.2	4.4	0.64	0.05	0.13	0.59	0.77	0.08	11		0.99
2	8/8/2001	615	400/7.6		28	82.4	3.5	11.3	1.64	0.02499	9.66	11.32	1.89	60		21
2	8/8/2001	1340	400/7.6	0.29	34	93.2	14.1	10.4	1.08	0.02499	9.32	10.42	1.86	49		29
2	8/9/2001	650	400/7.6		29	84.2	2.4	7.37	1.49	0.02499	5.88	7.39	1.57	49		21
2	8/9/2001	1315	400/7.6	0.29	33	91.4	13.4	10.9	0.8	0.02499	10.1	10.9	1.93	59		28
3	8/8/2001	700	400/6.5		25	77	1.8	3.47	2.16	0.18	1.31	3.65	0.66	16		2
3	8/8/2001	1300	400/6.5	0.96	27	80.6	2.6	3.98	2.01	0.2	1.97	4.18	3.57	7		2
3	8/9/2001	610	400/6.5		26	78.8	1.6	4.13	2.01	0.15	2.12	4.28	0.78	17		2
3	8/9/2001	1350	400/6.5		28	82.4	2.6	4.11	1.95	0.17	2.16	4.28	0.8	12		5
1	7/15/2003	600	400/7.8		25	77	4	0.76	0.08	0.05	0.68	0.81	0.08	11	2.499	
1	7/15/2003	1413	400/7.8	0.02	29	84.2	4.6	0.82	0.07	0.03	0.75	0.85	0.12	43	2.499	0.99
1	7/16/2003	550	400/7.8		23	73.4	3.3	0.77	0.1	0.04	0.67	0.81	0.09	26	2.499	0.99
1	7/16/2003	1230	400/7.8		28	82.4	5	0.63	0.09	0.04	0.54	0.67	0.08	8	2.499	0.99
2	7/15/2003	620	400/7.6		28	81.5	3.5	10.2	0.45	0.01	9.75	10.2	2.3	80	78	
2	7/15/2003	1350	400/7.6		31	87.8	8.3	12.9	0.79	0.03	12.11	12.9	2.42	88	74	24.9
2	7/16/2003	610	400/7.6	0.27	26	78.8	2.5	10.7	0.94	0	9.76	10.7	2.46	20	12	9.4
2	7/16/2003	1240	400/7.6		30	86	5.25	11.1	0.73	0.01	10.37	11.1	2.47	82	74	34.6
3	7/15/2003	645	400/6.5	0.75	25	77	1.4	6.7	2.35	0.00499	4.35	6.7	1.92	24	15	
3	7/15/2003	1340	400/6.5		30	86	4	4.93	1.8	0.09	3.13	5.02	1.6	17	9	5.41
3	7/16/2003	625	400/6.5		22	71.6	1.65	6.39	2.52	0	3.87	6.39	1.87	20	14	12
3	7/16/2003	1255	400/6.5		26	78.8	2.4	5.13	2.21	0.06	2.92	5.19	1.6	113	22	7
4	7/15/2003	700	400/4.4		25	77	3.2	1.29	0.07	0.36	1.22	1.65	0.31	17	2.499	0.99
4	7/15/2003	1310	400/4.4	0.92	29	84.2	5.8	1.17	0.06	0.34	1.11	1.51	0.32	16	2.499	0.99
4	7/16/2003	640	400/4.4		23	73.4	3.5	1.13	0.06	0.3	1.07	1.43	0.3	16	2.499	0.99
4	7/16/2003	1310	400/4.4		29	84.2	5.35	1.31	0.05	0.28	1.26	1.59	0.32	21	10	0.99

5	7/15/2003	720	400/3.2		26	78.8	1.8	1.5	0.23	0.39	1.27	1.9	0.46	19	2.499	0.99
5	7/15/2003	1300	400/3.2	1.04	28	82.4	2.4	1.47	0.24	0.37	1.23	1.84	0.46	19	2.499	0.99
5	7/16/2003	640	400/3.2		24	75.2	2	1.55	0.31	0.39	1.24	1.94	0.49	27	6	0.99
5	7/16/2003	1325	400/3.2		27	80.6	2.9	1.76	0.25	0.37	1.51	2.13	0.47	24	8	2.1

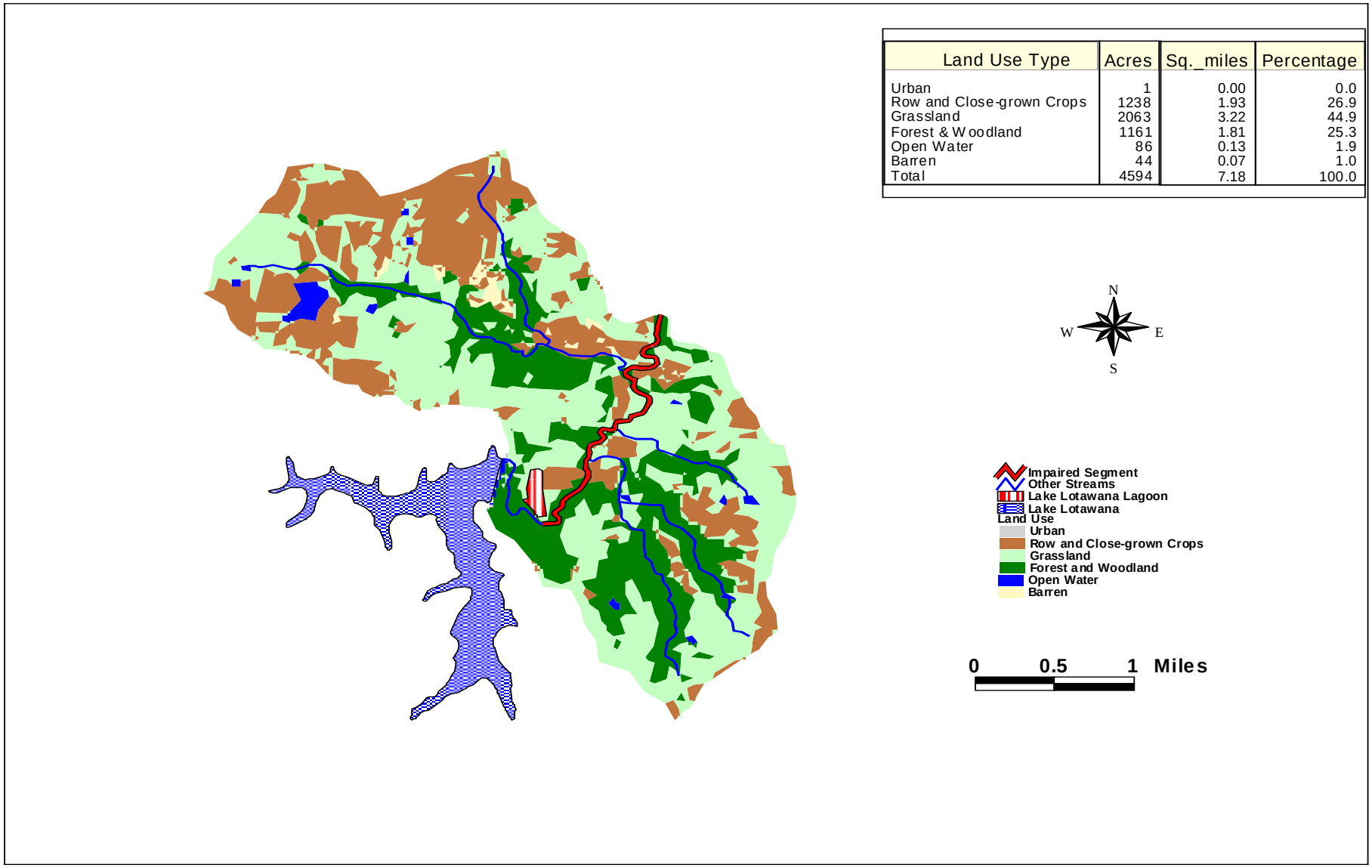


Attachment C, Lake Lotawana Spillway

Attachment D, Mid-Section shale layer, Lake Lotawana Spillway,

Attachment E, W. Fk. Sni-a-Bar at lagoon discharge

Attachment F, West Fork Sni-a-Bar Creek, near proposed new discharge point



Attachment G, Land use map